Anomalous Cognition in Lucid Dreams

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I. OBJECTIVE

The objective of this investigation is to determine if anomalous cognition can be ovserved during a lucid dream.*

* Definitions of terms can be found in Section V (i.e., Glossary) on page 6.

II. BACKGROUND

Dreams involving putative anomalous cognition (AC) have been part of every human culture from the times of ancient Greece to the present. The first serious attempt, however, to examine AC in dreams under controlled conditions began under the direction of Montague Ullman, MD in 1962 at the Community Mental Health Center of the Maimonides Medical Center in Brooklyn, New York. The research of AC in dreams continued until 1972 where the dream protocol was abandoned in favor of a simpler and more rapid approach to the study of AC. Child has summarized and critiqued this body of research in the *American Psychologist.*[1*]

In these studies, individuals were asked to sleep in a laboratory and be monitored for brain activity and eye movement. From these records, it was possible to tell when they were dreaming. Upon the onset of rapid eye movement (REM), an experimenter notified a sender, who was isolated in a remote laboratory, to begin attending to a randomly selected target. At the end of the REM period, the dreamer was awakened and asked to report the dream content. This procedure was repeated throughout the night using the same target material for each separate dream (e.g., up to ten). The assessment of the AC content was accomplished through independent judges. As described by Child, significant evidence for AC was observed under a variety of conditions.

The dreamers in these studies, however, were not necessarily focused upon the AC task. They slept as usual and, when asked, reported their dream content. In our pilot study we will focus the dreamer explicitly on the AC task using the methods of lucid dreaming.

A lucid dream is one during which the sleeper becomes conscious aware that the experience is a dream as opposed to the waking state. LaBerge et al. (1981) have found that it is possible for dreamers to know when they dreaming and to signal the waking world, through predetermined eye movements, indicating their awareness.[2] Using this ability, LaBerge et al. (1986 and 1988) conducted a number of psychophysiological studies to determine the differences between waking and dreaming from that prospective.[3,4] They found that dreaming is similar to the waking state. Motor action is mostly inhibited from the brain stem downward; however, the cerebral cortex appears not to "know" this.

In this preliminary pilot study, we will use the skills developed by LaBerge to teach individuals to lucid dream. Differing from the earlier AC dream studies, our dreamers will be instructed to adopt a proactive attitude to seek out and remember the AC target. In this way, we will determine the degree to which lucid dreaming can facilitate the reception of AC material.

* References may be found at the end of the document and are included in their entirety in the Appendix.

III. APPROACH

1. Receiver Selection

We will use two specialize populations from which to draw receivers for this pilot experiment:

(1) Experienced dreamers from LaBerg's research subjects , and
(2) Receivers who have demonstrated significant ability in other AC studies.

Currently, five and seven individuals have volunteered, respectively.

2. Target Selection

Targets will be chosen randomly from the standard set of 100 *National Geographic* magazine photographs.

3. Trial Definition

A trial is defined as a successful lucid dream during which the target material was examined and later transcribed in the waking state.

4. Lucid Dream Protocol

All receivers will undertake two forms of training in lucid dreaming: (1) They will complete a lucid dreaming home-study course developed by the Lucidity Institute (i.e., a subcontractor to SAIC), and (2) they will attend two weekend seminars, one at the beginning and one at the end of the proposed three-month pilot study. The first seminar, which was held in December, 1991, introduced receivers to lucid dreaming skills and the the use of the DreamLight, a lucid dream induction device. In previous studies, the DreamLight has been shown to enhance the frequency of lucid dreaming. The DreamLight consists of a sleep mask equipped with lights and eye movement sensors, which are attached to a small battery-operated computer. When the computer detects the eye movements of dreaming (i.e., REM) sleep, it causes the lights in the mask to flash briefly (i.e., either one or two flashes per second). The dreamer frequently incorporates the flashes into the ongoing dream, and thus experiences a cue to indicate that he or she is dreaming. Receivers will have free access to DreamLights during the duration of the study.

5. AC Baseline Measures

Each receiver will be asked to contribute eight trials in a waking state in the Cognitive Sciences Laboratory as an AC baseline series. The targets for this series will be chosen at random from a standardized target set that was developed from an earlier program. Each trial will be conducted as follows: After the

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receiver and an experimenter (i.e., called a monitor) enter the AC laboratory (i.e., an office with a single desk and two chairs), an assistant will use a computer random number generator to select a target from the baseline target pool. Both the receiver and the monitor will be blind to this specific choice. At a pre-arranged time, the monitor will encourage the receiver to draw and write impressions of the target material, which is located approximately 50 meters away. After approximately 15 minutes of casual questioning, the trial will end; the data will be copied; the originals will be secured; and the actual target will be presented as feedback to the receiver. The analysis will be discussed below.

6. Lucid Dream Trial Protocol

During the study, each receiver will attempt to provide six AC trials in a lucid dream state according to the following procedure:

(1) Each receiver will receive a sealed opaque envelope containing a target photograph chosen randomly from a predetermined set of 100. Receivers will place the target envelope in the room in which they are sleeping.

(2) Using the DreamLight, they will attempt, while dreaming, to open the envelope, memorize its content, and awaken as soon as possible.

(3) In the waking state, they will write and draw their impressions in detail.

(4) During the next day, they will mail the unopened envelope and their response to the principal investigator (PI) for analysis. Upon receipt, the PI will send back a copy of the target photograph as feedback and an additional sealed envelope for the next trial. This procedure will be repeated until six trials are obtained from each receiver.

7. Analysis

Traditional rank-ordering will be the method of analysis. The set of 100 *National Geographic* magazine photographs have been divided into 20 packets of five targets each. Within each pack, the targets have been selected to be as visually different from one another as possible. (A series of fuzzy sets were used to provide a quantitative method that was "fine tuned" by human judgment.) When a target is chosen from one of the target packs, the remaining four targets are considered as "decoy" targets for an analyst. For each trial, an analyst, is given the AC response and the target pack (i.e., five targets) from which the actual target was chosen. The analyst is required to rank order the targets from best to least match to the given response, regardless of the quality of the matches. The rank that is assigned to the intended target represents the value of the dependent variable for the trial. A sum-of-ranks is then computed for all the trials for each receiver, and effect sizes and p-values are determined from the known sum-of-ranks distribution.

The effect sizes from the lucid dreaming trials will be compared to each receiver's base line data and to historical AC data that is available for the experienced receivers.

IV. DISCUSSIONS AND CONCLUSIONS

The primary purpose of this pilot study is to determine if AC is possible in the lucid dream state. Because the trials will be conduced in each receiver's home and is unsupervised, it is possible that the target material can be compromised. By using standard enclosure techniques it is possible to determine if any casual attempt has been made to physically open the target material, but an experienced magician could foil the detection precautions. Thus we will be unable to conclude the existence of AC in a formal sense in this experiment.

Knowing the historical effect sizes from other AC studies and from the calibrations of the lucid dreamer population can provide circumstantial evidence of AC. If the the lucid dreaming effect sizes are not significantly smaller than the historical or base line effect sizes, then we will recommend that a careful, laboratory-based study be conducted.

V. GLOSSARY

Not all the terms defined below are germane to the this study, but they are included here for completeness. In a typical anomalous mental phenomena (AMP) task, we define:

- Anomalous Cognition (AC)—A form of information transfer in which all known sensorial stimuli are absent. That is, some individuals are able to gain access, by an as yet unknown process, to information that is not available to the known sensorial channels.
- Receiver—An individual who attempts to perceive and report information about a target.
- Agent—An individual who attempts to influence a target system.
- Target—An item that is the focus of an AMP task (e.g., person, place, thing, event).
- Target Designation—A method by which a specific target, against the backdrop of all other possible targets, is identified to the receiver (e.g., geographical coordinates).
- Sender/Beacon—An individual who, while receiving direct sensorial stimuli from an intended target, acts as a putative transmitter to the receiver.
- Monitor—An individual who monitors an AC session to facilitate data collection.
- Session—A time period during which AC data is collected.
- Protocol—A template for conducting a structured data collection session.
- Response—Material that is produced during an AC session in response to the intended target.
- Feedback—After a response has been secured, information about the intended target is displayed to the receiver.
- Analyst—An individual who provides a quantitative measure of AC.
- Specialty—A given receiver's ability to be particularly successful with a given class of targets (e.g., people as opposed to buildings).
- Lucid Dream—A dream during which an individual becomes aware of the dream.

REFERENCES

1. Irvin L. Child, "Psychology and Anomalous Observations," *American Psychologist,* Vol. 40., No. 11, pp. 1219-1230 (November 1985).
2. S. LaBerge, L. E. Nagel, W. C. Dement, and V. P. Zarcone, Jr., "Lucid Dreaming Verified by Volitional Communication During REM Sleep," *Perceptual and Motor Skills,* Vol. 52, pp. 727-732 (1981).
3. S. LaBerge, L. Levitan, and W. C. Dement, "Lucid Dreaming: Physiological Correlates of Consciousness during REM Sleep," *The Journal of Mind and Behavior,* Vol. 7, Nos. 2 and 3, pp.251-258 (1986).
4. *The Psychophysiology of Lucid Dreaming,* Ed. J. Gackenbach and S. LaBerge, pp. 135-153, Plenum Press, New York (1988).

APPENDIX

This appendix contains the full reprints of the following three papers:

(1) "Psychology and Anomalous Observations"
(2) "Lucid Dreaming Verified by Volitional Communication During REM Sleep"
(3) "Lucid Dreaming: Physiological Correlates of Consciousness during REM Sleep"
(4) *The Psychophysiology of Lucid Dreaming,* pp. 135-153

Psychology and Anomalous Observations

The Question of ESP in Dreams

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ABSTRACT: Books by psychologists purporting to offer critical reviews of research in parapsychology do not use the scientific standards of discourse prevalent in psychology. Experiments at Maimonides Medical Center on possible extrasensory perception (ESP) in dreams are used to illustrate this point. The experiments have received little or no mention in some reviews to which they are clearly pertinent. In others, they have been so severely distorted as to give an entirely erroneous impression of how they were conducted. Insofar as psychologists are guided by these reviews, they are prevented from gaining accurate information about research that, as surveys show, would be of wide interest to psychologists as well as to others.

In recent years, evidence has been accumulating for the occurrence of such anomalies as telepathy and psychokinesis, but the evidence is not totally convincing. The evidence has come largely from experiments by psychologists who have devoted their careers mainly to studying these anomalies, but members of other disciplines, including engineering and physics, have also taken part. Some psychologists not primarily concerned with parapsychology have taken time out from other professional concerns to explore such anomalies for themselves. Of these, some have joined in the experimentation (e.g., Crandall & Hite, 1983; Lowry, 1981; Radin, 1982). Some have critically reviewed portions of the evidence (e.g., Akers, 1984; Hyman, 1985). Some, doubting that the phenomena could be real, have explored nonrational processes that might encourage belief in their reality (e.g., Ayeroff & Abelson, 1976). Still others, considering the evidence substantial enough to justify a constructive theoretical effort, have struggled to relate the apparent anomalies to better established knowledge in a way that will render them less anomalous (e.g., Irwin, 1979) or not anomalous at all (e.g., Blackmore, 1984). These psychologists differ widely in their surmise about whether the apparent anomalies in question will eventually be judged real or illusory; but they appear to agree that the evidence to date warrants serious consideration.

Serious consideration of apparent anomalies seems an essential part of the procedures of science, regardless of whether it leads to an understanding of new discoveries or to an understanding of how persuasive illusions arise. Apparent anomalies—just like the more numerous observations that are not anomalous—can receive appropriate attention only as they become accurately known to the scientists to whose work they are relevant. Much parapsychological research is barred from being seriously considered because it is either neglected or misrepresented in writings by some psychologists—among them, some who have placed themselves in a prime position to mediate interaction between parapsychological research and the general body of psychological knowledge. In this article, I illustrate this important general point with a particular case, that of experimental research on possible ESP in dreams. It is a case of especially great interest but is not unrepresentative of how psychological publications have treated similar anomalies.

The Maimonides Research

The experimental evidence suggesting that dreams may actually be influenced by ESP comes almost entirely from a research program carried out at the Maimonides Medical Center in Brooklyn, New York. Among scientists active in parapsychology, this program is widely known and greatly respected. It has had a major indirect influence on the recent course of parapsychological research, although the great expense of dream-laboratory work has prevented it from being a direct model.

None of the Maimonides research was published in the journals that are the conventional media for psychology. (The only possible exception is that a summary of one study [Honorton, Krippner, & Ullman, 1972] appeared in convention proceedings of the American Psychological Association.) Much of it was published in the specialized journals of parapsychology. The rest was published in psychiatric or other medical journals, where it would not be noticed by many psychologists. Most of it was summarized in popularized form in a book (Ullman, Krippner, & Vaughan, 1973) in which two of the researchers were joined by a popular writer whose own writings are clearly not in the scientific tradition, and the book departs from the pattern of scientific reporting that characterizes the original research reports.

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How, then, would this research come to the attention of psychologists, so that its findings or its errors might in time be evaluated for their significance to the body of systematic observations upon which psychology has been and will be built? The experiments at Maimonides were published between about 1966 and 1972. In the years since—now over a decade—five books have been published by academic psychologists that purport to offer a scholarly review and evaluation of parapsychological research. They vary in the extent to which they seem addressed to psychologists themselves or to their students, but they seem to be the principal route by which either present or future psychologists, unless they have an already established interest strong enough to lead them to search out the original publications, might become acquainted with the experiments on ESP in dreams. I propose to review how these five books have presented knowledge about the experiments. First, however, I must offer a summary of the experiments; without that, my review would make sense only to readers already well acquainted with them.

The experiments at Maimonides grew out of Montague Ullman's observations, in his psychiatric practice, of apparent telepathy underlying the content of some dreams reported by his patients—observations parallel to those reported by many other psychiatrists. He sought to determine whether this apparent phenomenon would appear in a sleep laboratory under controlled conditions that would seem to exclude interpretations other than that of ESP. He was joined in this research by psychologist Stanley Krippner, now at the Saybrook Institute in San Francisco, and a little later by Charles Honorton, now head of the Psychophysical Research Laboratories in Princeton, New Jersey. Encouraged by early findings but seeking to improve experimental controls and identify optimal conditions, these researchers, assisted by numerous helpers and consultants, tried out various modifications of procedure. No one simple description of procedure, therefore, can be accurate for all of the experiments. But the brief description that follows is not, I believe, misleading as an account of what was generally done.

The Experimental Procedure

A subject would come to the laboratory to spend the night there as would-be percipient in a study of possible telepathic influence on dreams. He or she met and talked with the person who was going to serve as agent (that is, the person who would try to send a telepathic message), as well as with the two experimenters taking part that night, and procedures were explained in detail unless the percipient was a repeater for whom that step was not necessary. When ready to go to bed, the percipient was wired up in the usual way for monitoring of brain waves and eye movements, and he or she had no further contact with the agent or agent's experimenter until after the session was completed. The experimenter in the next room monitored the percipient's sleep and at the beginning of each period of rapid eye movements (REM), when it was reasonably certain the sleeper would be dreaming, notified the agent by pressing a buzzer.

The agent was in a remote room in the building, provided with a target picture (and sometimes accessory material echoing the theme of the picture) randomly chosen from a pool of potential targets as the message to be concentrated on. The procedure for random choice of a target from the pool was designed to prevent anyone else from knowing the identity of the target. The agent did not open the packet containing the target until isolated for the night (except for the one-way buzzer communication). Whenever signaled that the percipient had entered a REM period, the agent was to concentrate on the target, with the aim of communicating it telepathically to the percipient and thus influencing the dream the percipient was having. The percipient was oriented toward trying to receive this message. But of course if clairvoyance and telepathy are both possible, the percipient might have used the former—that is, might have been picking up information directly from the target picture, without the mediation of the agent's thoughts or efforts. For this reason, the term *general extrasensory perception* (*GESP*) would be used today, though the researchers more often used the term *telepathy*.

Toward the approximate end of each REM period, the percipient was awakened (by intercom) by the monitoring experimenter and described any dream just experienced (with prodding and questioning, if necessary, though the percipient of course knew in advance what to do on each awakening). At the end of the night's sleep, the percipient was interviewed and was asked for impressions about what the target might have been. (The interview was of course double-blind; neither percipient nor interviewer knew the identity of the target.) The dream descriptions and morning impressions and associations were recorded and later transcribed.

The original research reports and the popular book both present a number of very striking similarities between passages in the dream transcripts and the picture that happened to be the night's target. These similarities merit attention, yet they should in themselves yield no sense of conviction. Perhaps any transcript of a night's dreaming contains passages of striking similarity to any picture to which they might be compared. The Maimonides research, however, consisted of carefully planned experiments designed

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to permit evaluation of this hypothesis of random similarity, and I must now turn to that aspect.

Results

To evaluate the chance hypothesis, the researchers obtained judgments of similarity between the dream content and the actual target for the night, and at the same time obtained judgments of similarity between the dream content and each of the other potential targets in the pool from which the target had been selected at random. The person judging, of course, had no information about which picture had been randomly selected as target; the entire pool (in duplicate) was presented together, with no clue as to which picture had been the target and which ones had not. That is, in the experimental condition a picture was randomly selected from a pool and concentrated on by the agent, and in the control condition a picture was left behind in the pool. Any consistent difference between target and nontarget in similarity to dream content, exceeding what could reasonably be ascribed to chance, was considered an apparent anomaly.

The data available for the largest number of sessions came from judgments made by judges who had no contact with the experiment except to receive (by mail, generally) the material necessary for judging (transcripts of dreams and interview and a copy of the target pool). For many sessions, judgments were also available from the dreamer; he or she, of course, made judgments only after completing participation in the experiment as dreamer (except in some series where a separate target pool was used for each night and the dreamer's judgments could be made at the end of the session). For many sessions, judgments were made for the dream transcripts alone and for the total transcript including the morning interview; for consistency I have used the latter, because it involved judges who had more nearly the same information as the subjects.

The only form in which the data are available for all series of sessions is a count of hits and misses. If the actual target was ranked in the upper half of the target pool, for similarity to the dreams and interview, the outcome was considered a hit. If the actual target was ranked in the lower half of the pool, the outcome was considered a miss. The hit-or-miss score is presented separately in Table 1 for judges and for subjects in the first two data columns. Where information is not supplied for one or the other, the reason is generally that it was impossible for the researchers to obtain it, and for a similar reason the number of cases sometimes varies.[1]

Each data row in Table 1 refers to one segment of the research, and segments for the most part are labeled as they were in the table of Ullman et al. (1973, pp. 275–277). Segments that followed the general procedure I described—all-night sessions, with an agent concentrating on the target during each of the percipient's REM periods—are gathered together in the first eight lines, A through H (in five of these segments, all but A, C, and H, a single percipient continued throughout a series, and in four of these the percipient was a psychologist). Other types of segments are presented in the rest of the table. Lines I, J, and K summarize precognitive sessions; here the target was not selected until after the dreaming and interview had been completed. The target consisted of a set of stimuli to be presented directly to the percipient after it had been selected in the morning. Lines L and M represent GESP sessions in which the percipient's dreams were monitored and recorded throughout the night, but the agent was attempting to transmit only before the percipient went to sleep or just after, or sporadically. Line N refers to a few clairvoyance sessions; these were like the standard GESP sessions except that there was no agent (no one knew the identity of the target). Finally, Line O reports on some GESP sessions in which each dream was considered separately; these formed a single experiment with four percipients, comparing nights involving a different target for each REM period with nights involving repeated use of a single target.

Regardless of the type of session (considering the five types I have described), each session fell into one of two categories: (a) pilot sessions, in which either a new dreamer or a new procedure was being tried out; these appear in lines H, K, and N, or (b) sessions in an experimental series, planned in advance as one or more sessions for each of two or more subjects, or as a number of sessions with the same dreamer throughout. Most of the researchers' publications were devoted to the results obtained in the experimental series, but the results of the pilot sessions have also been briefly reported.

A glance at the score columns for judges and for subjects is sufficient to indicate a strong tendency for an excess of hits over misses. If we average the outcome for judges and for subjects, we find that hits exceed misses on every one of the 15 independent lines on which outcome for hits and misses differs. (On Line E hits and misses occur with equal frequency.) By a simple sign-test, this outcome would be significant beyond the 0.0001 level. I would not stress the exact value here, for several reasons. There was no advance

[1] Of course, usable judgments could not be obtained from the subject in precognitive sessions, because at the time of judging he or she would already know what the target had been. For Line F, the single subject was unable to give the extra time required for judging, and for Line O one of the four subjects failed to make judgments. In a few of the pilot sessions (Lines H, K, and N) only the subject's judgment was sought, and in some sessions only that of one or more judges; in a few the mean judges' rating was neither a hit nor a miss but exactly at the middle.

Table 1
Summary of Maimonides Results on Tendency for Dreams to Be Judged More Like Target Than Like Nontargets in Target Pool

Series	Judges' score		Subjects' score		z or t resulting from judgments		Sources
	Hit	Miss	Hit	Miss	Judges	Subjects	
GESP: Dreams monitored and recorded throughout night; agent "transmitting" during each REM period							
A. 1st screening	7	5	10	2	$z = 0.71^b$	$z = 1.33^b$	Ullman, Krippner, & Feldstein (1966)
B. 1st Erwin	5	2	6	1	$z = 2.53^b$	$z = 1.90^b$	Ullman et al. (1966)
C. 2nd screening	4	8	9	3	$z = -.25^b$	$z = 1.17^b$	Ullman (1969)
D. Posin	6	2	6	2	$z = 1.05^c$	$z = 1.05^c$	Ullman (1969)
E. Grayeb	3	5	5	3	$z = -.63^c$	$z = 0.63^c$	Ullman, Krippner, & Vaughan (1973)
F. 2nd Erwin	8	0			$t = 4.93^a$		Ullman & Krippner (1969)
G. Van de Castle	6	2	8	0	$t = 2.81^a$	$t = 2.74^a$	Krippner & Ullman (1970)
H. Pilot sessions	53	14	42	22	$z = 4.20^b$	$z = 2.21^b$	Ullman et al. (1973)
Precognition: Dreams monitored and recorded throughout night; target experience next day							
I. 1st Bessent	7	1			$t = 2.81^a$		Krippner, Ullman, & Honorton (1971)
J. 2nd Bessent	7	1			$t = 2.27^a$		Krippner, Honorton, & Ullman (1972)
K. Pilot sessions	2	0			$z = 0.67^c$		Ullman et al. (1973)
GESP: Dreams monitored and recorded throughout night; agent active only at beginning or sporadically							
L. Sensory bombardment	8	0	4	4	$z = 3.11^b$	$z = 0.00^c$	Krippner, Honorton, Ullman, Masters, & Houston (1971)
M. Grateful Dead	7	5	8	4	$z = 0.61^c$	$z = 0.81^c$	Krippner, Honorton, & Ullman (1973)
Clairvoyance: Dreams monitored and recorded throughout night; concealed target known to no one							
N. Pilot sessions	5	3	4	5	$z = 0.98^b$	$z = 0.00^b$	Ullman et al. (1973)
GESP: Single dreams							
O. Vaughan, Harris, Parise	105	98	74	79	$z = 0.63^c$	$z = -.32^c$	Honorton, Krippner, & Ullman (1972)

Note. GESP = general extrasensory perception. Italics identify results obtained with procedures that preserve independence of judgments in a series. For some series, the published source does not use the uniform measures entered in this table, and mimeographed laboratory reports were also consulted. Superscripts indicate which measure was available, in order of priority.
[a] Ratings. [b] Rankings. [c] Score (count of hits and misses).

plan to merge the outcomes for judges and subjects. Moreover, the various series could be split up in other ways. Although I think my organization of the table is very reasonable (and I did not notice this outcome until after the table was constructed), it is not the organization selected by Ullman et al. (1973); their table, if evaluated statistically in this same way, would not yield so striking a result. What is clear is that the tendency toward hits rather than misses cannot reasonably be ascribed to chance. There is some systematic—that is, nonrandom—source of anomalous resemblance of dreams to target.

Despite its breadth, this "hitting" tendency seems to vary greatly in strength. The data on single dreams—Line O—suggest no consistency. At the other extreme, some separate lines of the table look impressive. I will next consider how we may legitimately evaluate the relative statistical significance of

against eventual replicability. In the Maimonides series, likewise, three successive replications (Lines C, D, and E in Table 1) yielded no significant result, yet they are part of a program yielding highly significant overall results.

If results of such potentially great interest and scientific importance as those of the Maimonides program had been reported on a more conventional topic, one might expect them to be widely and accurately described in reviews of the field to which they were relevant, and to be analyzed carefully as a basis for sound evaluation of whether replication and extension of the research were indicated, or of whether errors could be detected and understood. What has happened in this instance of anomalous research findings?

Representation of the Maimonides Research in Books by Psychologists

It is appropriate to begin with E. M. Hansel's 1980 revision of his earlier critical book on parapsychology. As part of his attempt to bring the earlier book up to date, he included an entire chapter on experiments on telepathy in dreams. One page was devoted to a description of the basic method used in the Maimonides experiments; one paragraph summarized the impressive outcome of 10 of the experiments. The rest of the chapter was devoted mainly to a specific account of the experiment in which psychologist Robert Van de Castle was the subject (the outcome is summarized in Line G of my Table 1) and to the attempted replication at the University of Wyoming (Belvedere & Foulkes, 1971), in which Van de Castle was again the subject. Another page was devoted to another of the Maimonides experiments that was also repeated at the University of Wyoming (Foulkes et al., 1972). Hansel did not mention the replication by Globus et al. (1968), whose authors felt that the results encouraged further exploration. Hansel gave more weight to the two negative outcomes at Wyoming than to the sum of the Maimonides research, arguing that sensory cues supposedly permitted by the procedures at Maimonides, not possible because of greater care taken by the Wyoming experimenters, were responsible for the difference in results. He did not provide, of course, the full account of procedures presented in the original Maimonides reports that might persuade many readers that Hansel's interpretation is far from compelling. Nor did he consider why some of the other experiments at Maimonides, not obviously distinguished in the care with which they were done from the two that were replicated (e.g., those on Lines E, M, and O of Table 1) yielded a close-to-chance outcome such as Hansel might have expected sensory cuing to prevent.

Hansel exaggerated the opportunities for sensory cuing—that is, for the percipient to obtain by ordinary sensory means some information about the target for the night. He did this notably by misinterpreting an ambiguous statement in the Maimonides reports, not mentioning that his interpretation was incompatible with other passages; his interpretation was in fact erroneous, as shown by Akers (1984, pp. 128–129). Furthermore, Hansel did not alert the reader to the great care exerted by the researchers to eliminate possible sources of sensory cuing. Most important is the fact that Hansel did not provide any plausible account—other than fraud—of how the opportunities for sensory cuing that he claimed existed would be likely to lead to the striking findings of the research. For example, he seemed to consider important the fact that at Maimonides the agent could leave his or her room during the night to go to the bathroom, whereas in Wyoming the agent had a room with its own bathroom, and the outer door to the room was sealed with tape to prevent the agent from emerging. Hansel did not attempt to say how the agent's visit to the bathroom could have altered the details of the percipient's dreams each night in a manner distinctively appropriate to that night's target. The only plausible route of influence on the dream record seems to be deliberate fraud involving the researchers and their subjects. The great number and variety of personnel in these studies—experimenters, agents, percipients, and judges—makes fraud especially unlikely as an explanation of the positive findings; but Hansel did not mention this important fact.

It appears to me that all of Hansel's criticisms of the Maimonides experiments are relevant only on the hypothesis of fraud (except for the mistaken criticism I have mentioned above). He said that unintentional communication was more likely but provided no evidence either that it occurred or that such communication—in any form in which it might have occurred—could have produced such consistent results as emerged from the Maimonides experiments. I infer that Hansel was merely avoiding making explicit his unsupported accusations of fraud. Fraud is an interpretation always important to keep in mind, and it is one that could not be entirely excluded even by precautions going beyond those used in the Wyoming studies. But the fact that fraud was as always, theoretically possible hardly justifies dismissal of a series of carefully conducted studies that offer important suggestions for opening up a new line of inquiry into a topic potentially of great significance. Especially regrettable is Hansel's description of various supposed defects in the experiments as though they mark the experiments as being carelessly conducted by general scientific criteria, whereas in fact the supposed defects are relevant only if one assumes fraud. A reader who is introduced to the Maimonides research by Hansel's chapter is likely to get a totally erroneous impression of the care taken by the experimenters to avoid various possible sources of error. The one thing they could

not avoid was obtaining results that Hansel considered a priori impossible, hence evidence of fraud; but Hansel was not entirely frank about his reasoning.

An incidental point worth noting is that Hansel did not himself apply, in his critical attack, the standards of evidence he demanded of the researchers. His conclusions were based implicitly on the assumption that the difference of outcome between the Maimonides and the Wyoming experiments was a genuine difference, not attributable to random variation. He did not even raise the question, as he surely would have if, in some parallel instance, the Maimonides researchers had claimed or implied statistical significance where it was questionable. In fact, the difference of outcome might well have arisen from random error; for the percipient's own judgments the difference is significant at the 5% level (2-tailed), but for the outsiders' judgments it does not approach significance.

Another 1980 book is *The Psychology of Transcendence*, by Andrew Neher, in which almost 100 pages are devoted to "psychic experience." Neher differed from the other authors I refer to in describing the Maimonides work as a "series of studies of great interest" (p. 145), but this evaluation seems to be negated by his devoting only three lines to it and four lines to unsuccessful replications.

A third 1980 publication, *The Psychology of the Psychic*, by David Marks and Richard Kammann, provides less of a general review of recent parapsychology than Hansel's book or even Neher's one long chapter. It is largely devoted to the techniques of mentalists (that is, conjurors specializing in psychological rather than physical effects) and can be useful to anyone encountering a mentalist who pretends to be "psychic." Most readers are not likely to be aware that parapsychological research receives only limited attention. The jacket blurbs give a very different view of the book, as do the authors in their introductory sentences:

> ESP is just around the next corner. When you get there, it is just around the next corner. Having now turned over one hundred of these corners, we decided to call it quits and report our findings for public review. (Marks & Kammann, 1980, p. 4)

Given this introduction to the nature of the book, readers might suppose it would at least mention any corner that many parapsychologists have judged to be an impressive turning. But the Maimonides dream experiments received no mention at all.

Another volume, by psychologist James Alcock (1981), quite clearly purports to include a general review and evaluation of parapsychological research. Alcock mentioned (p. 6) that Hansel had examined the Maimonides experiments, but the only account of them that Alcock offered (on p. 163) was incidental to a discussion of control groups. By implication he seemed to reject the Maimonides experiments because they included no control groups. He wrote that "a control group, for which no sender or no target was used, would appear essential" (p. 163). Later he added, "One could, alternatively, 'send' when the subject was not in the dream state, and compare 'success' in this case with success in dream state trials" (p. 163). The first of these statements suggests a relevant use of control groups but errs in calling it essential; in other psychological research, Alcock would have doubtless readily recognized that within-subject control can, where feasible, be much more efficient and pertinent than a separate control group. His second statement suggests a type of experiment that is probably impossible (because in satisfactory form it seems to require the subject to dream whether awake or asleep and not to know whether he or she was awake or asleep). This second kind of experiment, moreover, has special pertinence only to a comparison between dreaming and waking, not to the question of whether ESP is manifested in dreaming.

Alcock, in short, did not seem to recognize that the design of the Maimonides experiments was based on controls exactly parallel to those used by innumerable psychologists in other research with similar logical structure (and even implied, curiously enough, in his own second suggestion). He encouraged readers to think that the Maimonides studies are beyond the pale of acceptable experimental design, whereas in fact they are fine examples of appropriate use of within-subject control rather than between-subjects control.

The quality of thinking with which Alcock confronted the Maimonides research appeared also in a passage that did not refer to it by name. Referring to an article published in *The Humanist* by Ethel Grodzins Romm, he wrote,

> Romm (1977) argued that a fundamental problem with both the dream telepathy research and the remote viewing tests is that the reports suffer from what she called "shoe-fitting" language; she cited a study in which the sender was installed in a room draped in white fabric and had ice cubes poured down his back. A receiver who reported "white" was immediately judged to have made a "hit" by an independent panel. Yet, as she observed, words such as "miserable", "wet", or "icy" would have been better hits. . . . Again, the obvious need is for a control group. Why are they not used? (p. 163)

What Romm described as "shoe fitting" (misinterpreting events to fit one's expectations) is an important kind of error that is repeatedly made in interpretation of everyday occurrences by people who believe they are psychic. But the dream telepathy research at Maimonides was well protected against this kind of error by the painstaking controls that Alcock seemed not to have noticed. Surely Romm must be referring to some other and very sloppy dream research?

Not at all. The details in this paragraph, and even more in Romm's article, point unmistakably, though inaccurately, to the fifth night of the first precognitive series at Maimonides. The actual details of target and response would alone deprive it of much of its value as an example of shoe fitting. As reported by Krippner, Ullman, & Honorton (1971), the target was a morning experience that included being in a room that was draped with white sheets. The subject's first dream report had included the statement, "I was just standing in a room, surrounded by white. Every imaginable thing in that room was white" (p. 201). There is more similarity here than Romm and Alcock acknowledged in mentioning from this passage only the single word "white."

More important, however, is the fact that the experiment they were referring to provided no opportunity for shoe fitting. The procedures followed in the experiment were completely misrepresented in a way that created the illusion that the possibility existed. There was no panel, in the sense of a group of people gathered together and capable of influencing each other. The judges, operating independently, separately judged every one of the 64 possible combinations of target and transcript yielded by the eight nights of the experiment, not just the eight correct pairings, and they had no clues to which those eight were. Their responses are hardly likely to have been immediate, as they required reading the entire night's transcript. Because each judge was working alone and was not recording times, there would have been no record if a particular response had been immediate, and no record of what particular element in the transcript led to an immediate response.

I looked up in a 1977 issue of *The Humanist* the article by Romm that Alcock cited. The half page on shoe-fitting language gave as examples this item from the Maimonides research and also the SRI remote-viewing experiments (Puthoff & Targ, 1976) done at SRI International. In both cases what was said was pure fiction, based on failure to note what was done in the experiments and in particular that the experimenters were well aware of the danger of shoe-fitting language and that the design of their experiments incorporated procedures to ensure that it could not occur. Romm's ignorance about the Maimonides research and her apparent willingness to fabricate falsehoods about it should be recognized by anyone who had read any of the Maimonides research publications. Yet Alcock accepted and repeated the fictions as though they were true. His presentation in the context of a book apparently in the scientific tradition seems to me more dangerous than Romm's original article, for anyone with a scientific orientation should be able to recognize Romm's article as propaganda. Its title, for example, is "When You Give a Closet Occultist a PhD, What Kind of Research Can You Expect?" and it repeatedly speaks of "cult phuds," meaning people with PhDs who are interested in parapsychological problems. Alcock's repetition of Romm's misstatements in a context lacking these clues may well be taken by many a reader as scholarly writing based on correct information and rational thought. Paradoxically, both Alcock's paragraph and Romm's article are excellent examples of the shoe-fitting error that both decry in others who are in fact carefully avoiding it.

The last of the five books that bring, or fail to bring, the Maimonides research to the attention of psychologists and their students is *Anomalistic Psychology: A Study of Extraordinary Phenomena of Behavior and Experience*, a 1982 volume by Leonard Zusne and Warren H. Jones. This is in many ways an excellent book, and it is also the one of the five that comes closest to including a general review of important recent research in parapsychology. Its brief account of the Maimonides dream experiments, however, misrepresented them in ways that should seriously reduce a reader's interest in considering them further.

Zusne and Jones's description of the basic procedure made three serious errors. First, it implied that one of the experimenters had a chance to know the identity of the target. ("After the subject falls asleep, an art reproduction is selected from a large collection randomly, placed in an envelope, and given to the agent" p. 260). In fact, precautions were taken to ensure that no one but the agent could know the identity of the target. Second, the authors stated that "three judges . . . rate their confidence that the dream content matches the target picture" (p. 260), leading the reader to suppose that the judges were informed of the identity of the target at the time of rating. In fact, a judge was presented with a dream transcript and a pool of potential targets and was asked to rate the degree of similarity between the transcript and each member of the pool, while being unaware of which member had been the target. Third, there was a similarly, though more obscurely, misleading description of how ratings were obtained from the dreamer.

This misinformation was followed by even more serious misrepresentation of the research and, by implication, of the competence of the researchers. Zusne and Jones (1982) wrote that Ullman and Krippner (1978) had found that dreamers were not influenced telepathically unless they knew in advance that an attempt would be made to influence them. This led, they wrote, to the subject's being "primed prior to going to sleep" through the experimenter's

> preparing the receiver through experiences that were related to the content of the picture to be telepathically transmitted during the night. Thus, when the picture was Van Gogh's Corridor of the St. Paul Hospital, which depicts a lonely figure in the hallways of a mental hospital, the receiver: (1)

heard Rosza's *Spellbound* played on a phonograph; (2) heard the monitor laugh hysterically in the room; (3) was addressed as "Mr. Van Gogh" by the monitor; (4) was shown paintings done by mental patients; (5) was given a pill and a glass of water; and (6) was daubed with a piece of cotton dipped in acetone. The receiver was an English "sensitive," but it is obvious that no psychic sensitivity was required to figure out the general content of the picture and to produce an appropriate report, whether any dreams were actually seen or not. (pp. 260–261)

If researchers were to report positive results of the experiment described here by Zusne and Jones and were to claim that it provided some positive evidence of ESP, what would a reader conclude? Surely, that the researchers were completely incompetent, but probably not that they were dishonest. For dishonesty to take such a frank and transparent form is hardly credible.

Incompetence of the researchers is not, however, a proper inference. The simple fact, which anyone can easily verify, is that the account Zusne and Jones gave of the experiment is grossly inaccurate. What Zusne and Jones have done is to describe (for one specific night of the experiment) some of the stimuli provided to the dreamer the next morning, *after* his dreams had been recorded and his night's sleep was over. Zusne and Jones erroneously stated that these stimuli were provided *before* the night's sleep, to prime the subject to have or falsely report having the desired kind of dream. The correct sequence of events was quite clearly stated in the brief reference Zusne and Jones cited (Ullman & Krippner, 1978), as well as in the original research report (Krippner, Honorton, & Ullman, 1972).

I can understand and sympathize with Zusne and Jones's error. The experiment they cited is one in which the nocturnal dreamer was seeking to dream in response to a set of stimuli to be created and presented to him the next morning. As may be seen in Table 1, results from such precognitive sessions (all done with a single subject) were especially strong. This apparent transcendence of time as well as space makes the precognitive findings seem at least doubly impossible to most of us. An easy misreading, therefore, on initially scanning the research report, would be to suppose the stimuli to have been presented partly in advance (because some parts obviously involved a waking subject) and partly during sleep.

This erroneous reading on which Zusne and Jones based their account could easily have been corrected by a more careful rereading. In dealing with other topics, they might have realized the improbability that researchers could have been so grossly incompetent and could have checked the accuracy of their statements before publishing them. Zusne and Jones are not alone in this tendency to quick misperception of parapsychological research through preconception and prejudice; we have already seen it in Alcock's book. Alcock (1983) wrote the review of Zusne and Jones's book for *Contemporary Psychology*, the book-review journal of the American Psychological Association, and he did not mention this egregious error, even though very slight acquaintance with the Maimonides research should suffice to detect it.

Discussion

The experiments at the Maimonides Medical Center on the possibility of ESP in dreams clearly merit careful attention from psychologists who, for whatever reason, are interested in the question of ESP. To firm believers in the impossibility of ESP, they pose a challenge to skill in detecting experimental flaws or to the understanding of other sources of error. To those who can conceive that ESP might be possible, they convey suggestions about some of the conditions influencing its appearance or absence and about techniques for investigating it.

This attention is not likely to be given by psychologists whose knowledge about the experiments comes from the books by their fellow psychologists that purport to review parapsychological research. Some of those books engage in nearly incredible falsification of the facts about the experiments; others simply neglect them. I believe it is fair to say that none of these books has correctly identified any defect in the Maimonides experiments other than ones relevant only to the hypothesis of fraud or on inappropriate statistical reasoning (easily remedied by new calculations from the published data). I do not mean that the Maimonides experiments are models of design and execution. I have already called attention to a design flaw that prevents sensitive analysis of some of the experiments; and the control procedures were violated at one session, as Akers (1984) pointed out on the basis of the full information supplied in the original report. (Neither of these genuine defects was mentioned in any of the five books I have reviewed here, an indication of their authors' general lack of correct information about the Maimonides experiments.)

Readers who doubt that the falsification is as extreme as I have pictured it need only consult the sources I have referred to. Their doubt might also be reduced by familiarity with some of James Bradley's research (1981, 1984). In his 1984 article, he reported similar misrepresentations of fact on a topic, robustness of procedures of statistical inference, on which psychologists would not be thought to have nearly the strength of preconception that many are known to have about ESP. How much more likely, then, falsification on so emotionally laden a topic as ESP is for many psychologists! In the earlier article, Bradley (1981) presented experimental evidence (for college students, in this case, not psychologists) that confi-

dence in the correctness of one's own erroneous opinions is positively correlated with the degree of expertise one believes oneself to have in the field of knowledge within which the erroneous opinion falls. This finding may help in understanding why the authors of some of these books did not find it necessary to consider critically their own erroneous statements.

A very considerable proportion of psychologists have a potential interest in the question of ESP. In a recent survey (Wagner & Monnet, 1979) of university professors in various fields, 34% of psychologists were found to consider ESP either an established fact or a likely possibility, exactly the same proportion as considered it an impossibility. In this survey, psychologists less frequently expressed a positive opinion than did members of other disciplines, a finding that may be attributable to psychologists' better understanding of sources of error in human judgment. There seems to be no equally sound reason for the curious fact that psychologists differed overwhelmingly from others in their tendency to consider ESP an impossibility. Of natural scientists, only 3% checked that opinion; of the 166 professors in other social sciences, not a single one did.

Both of these groups of psychologists have been ill served by the apparently scholarly books that seem to convey information about the dream experiments. The same may be said about some other lines of parapsychological research. Interested readers might well consult the original sources and form their own judgments.

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LUCID DREAMING VERIFIED BY VOLITIONAL COMMUNICATION DURING REM SLEEP[1]

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Summary.—The occurrence of lucid dreaming (dreaming while being conscious that one is dreaming) has been verified for 5 selected subjects who signaled that they knew they were dreaming while continuing to dream during unequivocal REM sleep. The signals consisted of particular dream actions having observable concomitants and were performed in accordance with presleep agreement. The ability of proficient lucid dreamers to signal in this matter makes possible a new approach to dream research—such subjects, while lucid, could carry out diverse dream experiments marking the exact time of particular dream events, allowing derivation of precise psychophysiological correlations and methodical testing of hypotheses.

That we sometimes dream while knowing that we are dreaming was first noted by Aristotle. According to accounts of conscious or "lucid" dreaming, as this phenomenon is commonly termed, the dreamer can possess a consciousness fully comparable in coherence, clarity, and cognitive complexity to that of the waking state, while continuing to dream vividly (Van Eeden, 1913; Brown, 1936; Green, 1968; Tart, 1979; LaBerge, 1980b). As a result of theoretical assumptions about the nature of dreaming, contemporary dream researchers have questioned whether these experiences take place during sleep or during brief periods of hallucinatory wakefulness. The purpose of the present study was to give an empirical answer to this question by determining the physiological conditions in which lucid dreaming occurs.

Our experimental approach was suggested by previous investigations (Antrobus, *et al.*, 1965; Salamy, 1970; Brown & Cartwright, 1978), showing that sleeping subjects are sometimes able to produce behavioral responses highly correlated with dreaming. Since these subjects have not, according to Cartwright (1978), been conscious of making the responses, these earlier studies do not provide evidence for voluntary action (and thus, reflective consciousness) during sleep. However, we reasoned that what could be done unconsciously could also be done consciously.

The experience of one of us (S.P.L.) indicated that, if subjects became aware they were dreaming, they could also remember to perform previously

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intended dream actions. Because dreamed gaze and limb actions have sometimes shown very good correlations with polygraphically recorded eye movements and muscle activation (Rechtschaffen, 1973), it seemed plausible that lucid dreamers could signal that they knew they were dreaming by means of intentional dream actions having observable physiological correlates.

Method and Results

Five subtjects, trained in the method of lucid dream induction (MILD) described by LaBerge (1980c), were selected on the basis of their claimed ability to have lucid dreams on demand, and studied for 2 to 20 nonconsecutive nights (see Table 1). Standard polysomnograms (Rechtschaffen & Kales, 1968), i.e., electroencephalogram (EEG), electro-oculogram (EOG), and chin electromyogram (EMG), were recorded, as well as left and right wrist EMG (for signaling). The subjects attempted to follow a predetermined procedure of signaling whenever they became aware that they were dreaming. A variety of signals were specified, generally consisting of a combination of dreamed eye movements and a pattern of left and right dream-fist clenches. The subjects demonstrated the signals during pre-recording calibrations but were asked not to practice further while awake.

In the course of the study, 35 lucid dreams were reported subsequent to spontaneous awakening from various stages of sleep as follows: rapid-eye-movement (REM) sleep in 32 cases, non-REM (NREM) Stage 1 twice, and during the transition from NREM Stage 2 to REM once.

The subjects reported signaling during 30 of these lucid dreams. After each recording, the reports mentioning signals were submitted along with the respective polysomnogram to a judge uninformed of the times of the reports.

TABLE 1

SUMMARY OF LUCID DREAM SIGNALING EXPERIMENTS

Subject (age, sex)	Nights recorded	Lucid dreams reported (sleep stage)	Lucid dream signals verified*/reported
S.L. (32 yr., M)	20	17 (REM)	14/15
R.K. (28 yr., M)	4	5 (REM)	3/5
L.L. (34 yr., F)	2	1 (REM)	0/0
		2 (NREM—1)	0+/1
B.K. (27 yr., F)	6	6 (REM)	5/6
		1 (NREM—2/REM)++	0/0
S.P. (26 yr., M)	2	2 (REM)	2/2

*Blindly matched for correspondence between reported and observed signals.
+On awakening from NREM Stage 1 sleep (2 min. after having awakened from REM), the subject reported performing the agreed-upon signal during a vivid and lengthy lucid dream. However, neither her EOG nor wrist EMG showed any sign of the reported signals, as might be expected from the normal lack of correspondence between dream gaze and eye movements during descending Stage 1 sleep (Rechtschaffen, 1973).
++The subject awoke, in this case, during the transition from NREM Stage 2 to REM.

The judge was asked to determine whether one (or none) of the polysomnographic epochs corresponded with the reported lucid dream signal. In 24 cases, the judge was able to select the appropriate 30-sec. epochs (out of about 1000 per polysomnogram) on the basis of correspondence between reported and observed signals (Table 1). The probability that the selections were correct by chance alone is astronomically small. All signals associated with lucid dream reports occurred during epochs of unambiguous REM sleep scored according to the standard criteria (Rechtschaffen & Kales, 1968). The lucid dream signals were followed by an average of 1 min. (range: 5 to 450 sec.) of uninterrupted REM sleep.

Inspection of the polysomnographic epochs preceding the lucid dream signal reports suggested the failures with blind matching (the "false negatives") were due to high baseline EOG and wrist EMG activity, resulting in an unfavorable signal-to-noise ratio. However, no clear instances of signals were observed except where reported, i.e., there were no "false positives." On the other hand, in many cases, the reported signals were unequivocal (see Figs. 1 and 2). The most reliable signal was a series of extreme horizontal eye movements (left, right, left, right.)

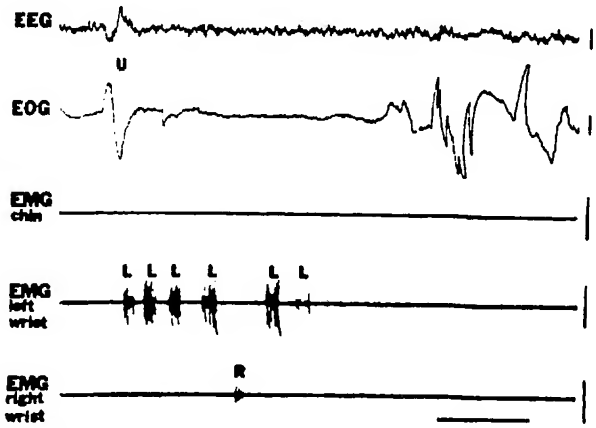

FIG. 1. Polygraph record of a subject signaling that he knows he is dreaming. The subject awoke approximately 20 sec. after this excerpt and reported recognizing that he was dreaming and performing the agreed upon signal in the dream, i.e., he directed his dream gaze upwards momentarily (U) and then executed a sequence of dreamed left (L) and right (R) fist clenches, Morse code for S.L., the subject's initials. Note that unlike the predominantly horizontal eye movements (above right), the extreme upward eye movement (U) produces characteristic artifact in the EEG channel. All three of the scoring criteria for REM sleep are met: low amplitude chin EMG, episodic REMs, and low-voltage, mixed-frequency EEG (Rechtschaffen & Kales, 1968). The EEG shows occasional 10-Hz (alpha) activity as is normal during REM sleep (Rechtschaffen, 1973); integration of the alpha band-pass filtered EEG showed the amount of alpha activity during the lucid dream did not significantly differ from that during the preceding non-lucid portion of the REM period. (Calibrations: 50μV; 5 sec.)

The most complicated signal (shown in Fig. 1) consisted of a single upward dream-eye movement followed by a series of left (L) and right (R) dream-fist clenches in the order "LLL LRLL." This sequence is equivalent to the subject's initials in Morse code (LLL = . . . = S; LRLL = . -- . . = L). The complexity of this signal argues against the possibility that the EMG discharges might be spontaneous.

That all cases of lucid dream signaling occurred during epochs scored as REM sleep specifies, to a certain extent, the physiology of lucid dreaming as "a relatively low voltage, mixed frequency EEG in conjunction with episodic REMs and low amplitude electromyogram (EMG)" (Rechtschaffen & Kales, 1968). This definition allows variation in the three parameters, the details of which will be reported elsewhere. In brief, the variations in the EEG patterns of the lucid dream polysomnograms were typical of REM sleep, i.e., sporadic "saw-tooth" waves as well as alpha and theta rhythm, and not wakefulness. The occasional, but normal, appearance of alpha rhythm (a brain wave usually associated with wakefulness), in the EEG during REM periods raises the possibility that lucid dreaming could occur during momentary partial arousals or "micro-awakenings" (Schwartz & Lefebvre, 1973). However, alpha rhythm need not be present during lucid dream signaling, as is shown by Fig. 2. Furthermore, some of the lucid dreams were several minutes long, ruling out any explanation based on the notion of brief intrusions of wakefulness.

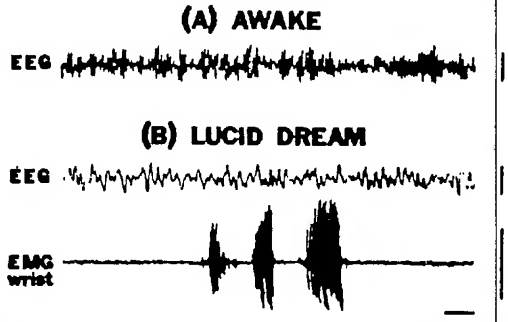

FIG. 2. Comparison of EEG (C3/A2) during lucid dream signaling (B) and immediately after awakening (A). The continuous waking alpha (10 Hz) activity for this subject is clearly distinct from the mixed frequency patterns during REM sleep. Although other EEG patterns are compatible with wakefulness, the tracing illustrated is the pattern normally exhibited when subjects awaken from sleep. The 2- to 4-Hz EEG activity prominent in the lucid dream sample (B) is highly characteristic of REM sleep. (Calibrations: 50 μV; 1 sec.)

DISCUSSION

How do we know that the subjects were "really asleep" when they communicated the signals? If we allow perception of the external world as a

criterion of being awake, we can conclude the subjects were indeed asleep: Although they knew they were in the laboratory, this knowledge was a matter of memory, not perception; upon awakening, they reported having been totally in the dream world and not in sensory contact with the external world. Neither were the subjects merely not attending to the environment, e.g., as when absorbed in reading or daydreaming; according to their reports, they were specifically aware of the *absence* of sensory input from the external world. If subjects were to claim to have been awake while showing physiological signs of sleep, or vice versa, we might doubt their subjective reports. However, in the present case, the subjective accounts and physiological measures are in clear agreement, and it would be extremely unparsimonious to suppose that subjects who believed themselves to be asleep while showing physiological indications of sleep were actually awake.

The two principal conclusions of this study are that lucid dreaming can occur during REM sleep and that it is possible for lucid dreamers to signal intentionally to the environment while continuing to dream. These findings have both theoretical and practical consequences. The first result shows that under certain circumstances, dream cognition during REM sleep can be much more reflective and rational than has been commonly assumed. Evidence indicating that lucid dreaming is a learnable skill (LaBerge, 1979, 1980a, 1980b, 1980c), taken with the second result, suggests the feasibility of a new approach to dream research: lucidly dreaming subjects could carry out diverse experiments marking the exact time of occurrence of particular dream events, which would allow the derivation of precise psychophysiological correlations and methodical testing of hypotheses.

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Lucid Dreaming: Physiological Correlates of Consciousness during REM Sleep

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Reports of lucid dreaming (dreaming while being conscious that one is dreaming) were verified for 13 selected subjects who signaled by means of voluntary eye-movements that they knew they were dreaming while continuing to dream during unequivocal REM sleep. Physiological analysis of the resulting 76 signal-verified lucid dreams (SVLDs) revealed that elevated levels of automatic nervous system activity reliably occured both during and 30 seconds preceding the onset of SVLDs, implicating physiological activation as a necessary condition for reflective consciousness during REM dreaming. The ability of proficient lucid dreamers to deliberately perform dream actions in accordance with pre-sleep agreement makes possible the methodical and precise determination of psycho-physiological correspondence during REM dreaming.

It is not the usual case for dreamers to know that they are dreaming while they are dreaming. Nevertheless, significant exceptions sometimes occur when dreamers realize while dreaming that they are dreaming. Although lucid dreaming, as this phenomenon is called, has been known since the time of Aristotle, it has only recently become the subject of scientific inquiry (LaBerge, 1985a). Studies in our laboratory and elsewhere have demonstrated that lucid dreams occur almost exclusively during REM sleep (Dane, 1983; Fenwick, Schatzman, Worsley, Adams, Stone, and Baker, 1984; Hearne, 1978; LaBerge, Nagel, Dement, and Zarcone, 1981; Tyson, Ogilvie, and Hunt, 1984). However, until now little light has been shed on the detailed physiology of dream lucidity. The purpose of the present study was to investigate physiological correlates of REM lucid dreams.

The volunteer subjects were seven males and six females (age ranging from

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21-51; mean=28), trained in the MILD technique of lucid dream induction (see LaBerge, 1980). Subjects were selected on the basis of their claimed ability to have lucid dreams on demand and were studied in a sleep laboratory for 2-25 non-consecutive nights. Standard polysomnograms (Rechtschaffen and Kales, 1968) (i.e., electroencephalogram [EEG], electro-oculogram [EOG], and chin electromyogram [EMG]) were recorded, as well as, in certain cases, a variety of additional physiological measures.

Before bedtime on recording nights subjects were instructed to immediately signal whenever they realized they were dreaming. A variety of signals were specified, typically two pairs of extreme horizontal eye-movements (left, right, left, right). In some cases, subjects received additional instructions to carry out specific activities in the dream state once they became lucid.

In the course of the study, 88 lucid dreams were reported subsequent to spontaneous awakenings from the following stages of sleep, scored according to the standard criteria (Rechtschaffen and Kales, 1968): REM in 83 cases (94.3%), NREM Stage-1 in four cases (4.5%), and at the transition between NREM Stage-2 and REM in one case (1.1%). The subjects reported signaling in 80 cases (90.9%), all following REM awakenings (96.4% of the REM reports).

After each recording, reported lucid dream signals were verified by means of a blind judging procedure previously detailed elsewhere (LaBerge et al., 1981). Briefly, the reports mentioning lucidity signals were submitted along with the respective polysomnograms to a judge who attempted to determine which 30" epoch of the physiological records corresponded to a given reported signal. The judge (blind to the times the reports were made) successfully matched 76 (95%) of the reported signals to an epoch from the correct REM period. The probability that such a large number of matches could have been made by chance is infinitesmally small.

The 13 subjects contributed varying numbers of signal-validated lucid dreams (SVLDs) ranging from 1-25, each with the median number of SVLDs per subject being four. Although four subjects furnished a single SVLD each while another two subjects together supplied 43 (56% of the total), the number of SVLDs contributed by the two sexes did not significantly differ. Potential problems arising from the unequal N of observations per subject were averted by statistically analysing summary scores for all physiological variables (i.e., the mean of each subject's mean values, yielding a maximum $N=13$).

The polysomnograms corresponding to each of the SVLDs were sleep-staged. Additionally, every SVLD REM period was divided into 30 second epochs aligned with the lucidity onset signal; up to 60 epochs of data from the preceding (non-lucid) REM period and 15 epochs from the lucid dream were collected. For each epoch, sleep stage (STATE) was scored and rapid eye movements (EM) were counted; if scalp skin-potential responses were observable as artifacts in the EEG, these were also counted (SP). Heart rate (HR) and respiration rate (RR) were also determined for SVLDs recorded with the relevant measures.

For the first lucid epoch (during signals), STATE was unequivocal REM in 70 cases (92%). The remaining six SVLDs were less than 30" long and hence technically unscorable by the orthodox (Rechtshaffen and Kales, 1968) criteria. For these cases, the entire SVLD was treated as a single epoch and scored as if they were of standard length; with this modification, all qualified as REM. The lucid dream signals were followed by an average of 115 seconds (range: 5 to 490 seconds) of uninterrupted REM sleep.

Anecodotal reports indicate that lucid dreams are sometimes initiated from the waking state, but more frequently from the dream state (Green, 1968; LaBerge, 1985a). Since lucid dreams initiated in these two ways would be expected to differ physiologically, SVLDs were dichotomously classified as either "Wake-initiated" (WILD) or "Dream-initiated" (DILD), depending on whether or not the reports mentioned a transient awakening (i.e., conscious perception of the external environment). Fifty-five (72%) of the SVLDs were classified as DILDs and the remaining 21 (28%) as WILDs. For all 13 subjects, DILDs were more common than WILDs (binomial test, $p<.0001$). Compared to DILDs, WILDs were more frequently immediately preceded by physiological indications of arousal ($\chi^2=38.3$, 1df, $p<.0001$), establishing the construct validity of the classification dimension.

Figure 1 illustrates a typical DILD. Four channels of physiological data (central EEG [C_3-A_2], left and right eye-movements [LOC and ROC], and chin muscle tone [EMG]) from the last 8 minutes of a 30 minute REM period are shown. Upon awakening the subject reported having made five eye movement (EM) signals (labeled 1-5). The first signal (1, two pairs of left-right EMs) marked the onset of lucidity. During the following 90 seconds the subject "flew about" exploring his dream world until he believed he had awakened, at which point he made the signal for awakening (2, four pairs of left-right EMs). After another 90 seconds the subject realized he was still dreaming and signaled (3) with three pairs of EMs. Realizing that this was too many, he correctly signaled with two pairs (4). Finally, upon awakening two minutes later he signaled appropriately (5, four pairs of EMs).

Figure 2 illustrates six channels of physiology (left and right temporal EEG [T3 and T4], left and right eye-movements [LOC and ROC], chin muscle tone [EMG], and electrocardiogram [ECG]) for a typical WILD. The subject awoke at 1 and after 40 seconds returned to REM sleep at 2, and realized he was dreaming 15 seconds later at 3. Next he carried out the agreed-upon dream actions, singing between signals 3 and 4, and counting between signals 4 and 5. This allowed comparison of left and right hemisphere activation during the two tasks (LaBerge and Dement, 1982a).

Physiological comparison of lucid versus non-lucid epochs revealed that lucid

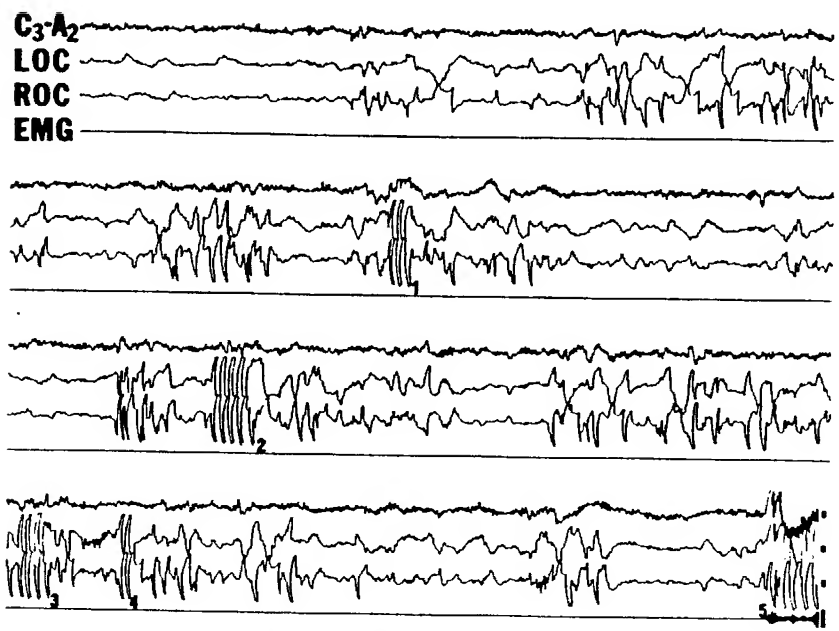

Figure 1: A typical dream-initated lucid dream (DILD). [Calibrations are 50μV and 5 seconds.]

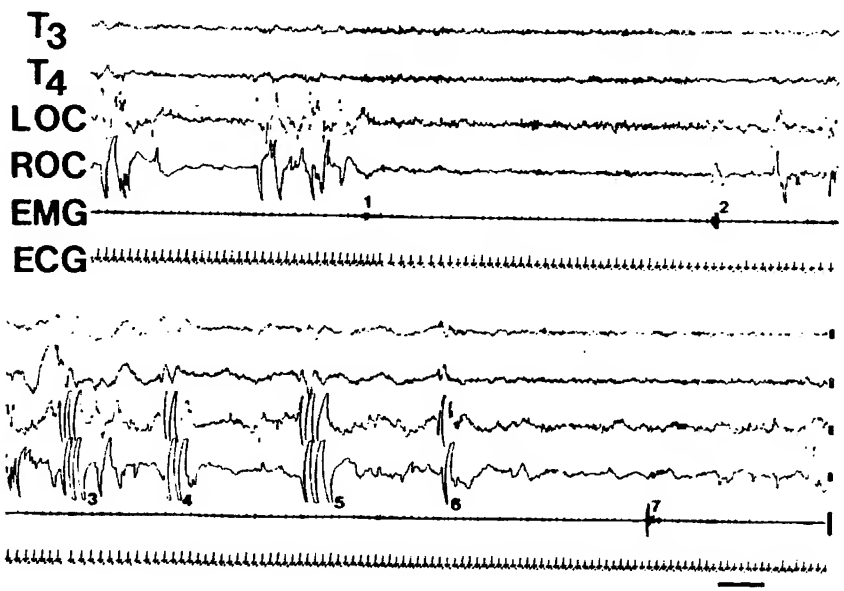

Figure 2: A typical lucid dream initiated from a transient awakening during REM (WILD). [Calibrations are 50 μV and 5 seconds.]

Table 1

Comparisons of Physiological Variables for Lucid and Non-lucid Epochs

Variables are averaged over REM Periods and subjects. L = mean value for lucid epochs; N = mean value for non-lucid epochs; LND = mean value of difference score for lucid minus non-lucid epochs.

REM density (EM)	
EML > EMN	[$t(12)=4.36$; $p<.0001$]
EMLND > 0	[$t(12)=3.93$; $p<.002$]
Respiration Rate (RR)	
RRL > RRN	[$t(7)=4.07$; $p<.004$]
RRLND > 0	[$t(7)=4.49$; $p<.004$]
Heart Rate (HR)	
HRL > HRN	[$t(8)=2.54$; $p<.025$]
HRLND > 0	[$t(8)=2.91$; $p<.01$]
Skin Potential (SP)	
SPL > SPN	[$t(8)=3.00$; $p<.01$]
SPLND >	[$t(8)=2.41$; $p<.01$]

epochs of SVLD REM periods are characterized by significantly higher levels of physiological activation than are epochs of preceding non-lucid REM from the same REM period (see Table 1).

In order to follow the temporal variations of physiology correlated with the development and initiation of lucidity, for each SVLD REM period the physiological variables were converted to Z-scores and averaged across dreams and subjects. Figure 3 is a histogram of the resultant mean Z-scores for the ten minutes before and the five minutes after the initiation of lucidity. Note the highly significant increases in physiological activation during the 30 seconds before and after lucidity onset.

Physiological data (EM, RR, HR, and SP) were scored for 61 control non-lucid REM periods (NLREMPs), derived from the same 13 subjects, in order to allow comparison with SVLDs (LDREMPs). Mean values for EM and SP were significantly higher for LDREMPs than NLREMP controls (RR and HR did not differ).

If lucid dream probability (LDPROB) were constant across time during REM periods, lucid dreams should occur most frequently in the first few minutes of REM. On this hypothesis, LDPROB should be a monotonically decreasing function of time into REM, following the survivor function of mean REM period lengths (REMLEN). Although REMLEN proved to be an excellent predictor of LDPROB ($r=.97$, $p<.005$), our data showed that LDPROB does not reach its maximum before about five to seven minutes into REM. The discrepancy between theory and observation is particularly acute for WILDs: only one out of 21 WILDs occurred during the first four minutes of REM, suggesting that there must be another factor contributing to the distribution

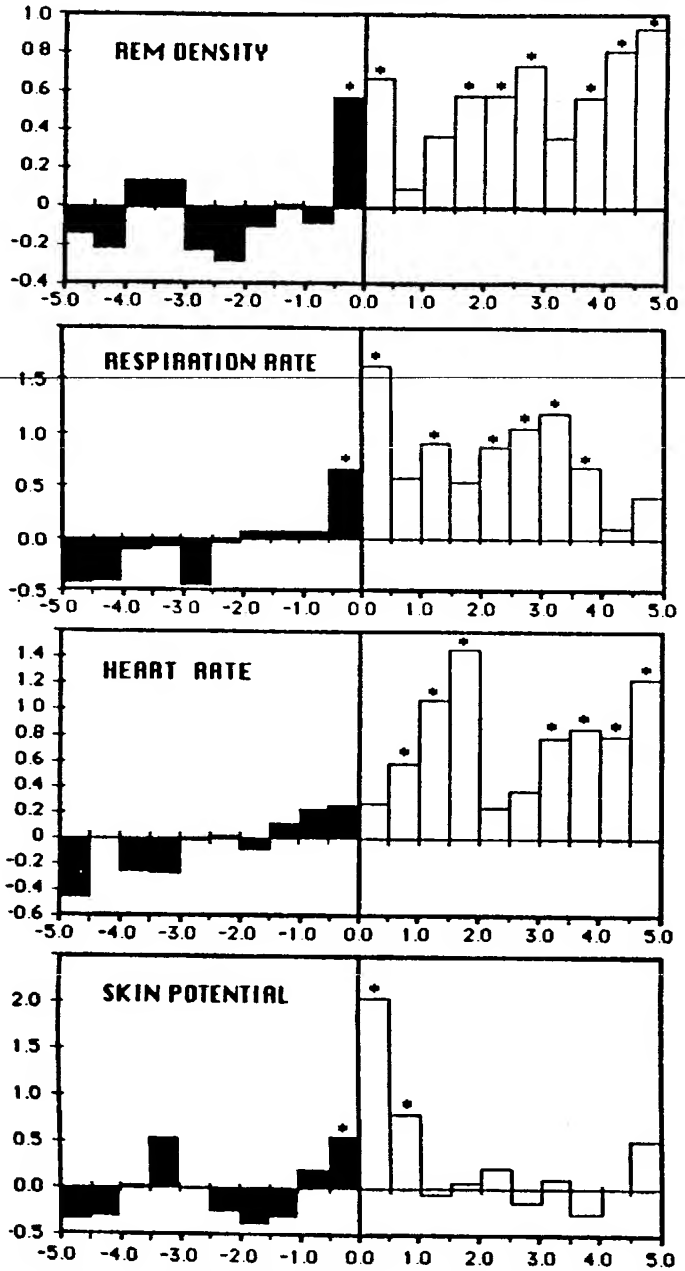

Figure 3: Histograms of mean Z-scores for EM, RR, HR, and SP. Bins are 30 seconds in length with t=0 representing the signaled onset of lucidity. Ns vary with variable and bin, but all values are averaged across lucid dreams and subjects. (*$p<.05$)

of lucid dreams within REM periods.

Having found that lucid dreams reliably occur during activated REM, we predicted that LDPROB would share significant variance with measures of CNS activation. Since it has been reported that eye-movement density starts at a low level at the beginning of REM periods and increases until it reaches a peak after approximately five to seven minutes (Aserinsky, 1971), we hypothesized that LDPROB should follow a parallel development. Accordingly, we found that mean eye-movement density (EM) correlated positively and significantly with LDPROB ($r=.66$, $p<.01$). In a regression of LDPROB on EM and REMLEN, both variables entered significantly, giving an adjusted multiple $R=.98$ ($p<.005$).

Lucid dreams have been widely reported to characteristically occur "almost exclusively" towards the end of the night (Garfield, 1975; Green, 1968; LaBerge, 1985a). Cohen (1979) has argued that the left hemisphere shows a gradual increase in dominance across the night. Since left-hemisphere abstract symbolic functions are undoubtedly crucial for lucid dreaming, Cohen's GILD hypothesis led us to predict (LaBerge, 1985b) that the probability of dream lucidity should increase with time of night.

For each subject a median split for total REM time was determined; 11 of the subjects had more lucid dreams in the later half of REM than in the earlier half (binomial test; $p<.01$). For the combined sample, relative lucidity probability was calculated for REM periods 1-6 of the night by dividing the total number of lucid dreams observed in a given REM period by the corresponding total time in stage REM for the same REM period. A regression analysis clearly demonstrated that relative lucidity probability was a linear function of ordinal REM period number ($r=.98$, $p<.0001$). No measure of activation (EM, RR, HR, SP) even approached significance when entered into the regression equation. These results strongly support the conclusion that lucid dreams are more likely to occur in later REM periods than in earlier ones—provided, of course, that sleep is continued long enough.

Our demonstration that lucid dreams are reliably associated with elevated levels of physiological activation, may raise a question: why is lucid dreaming the exception rather than the rule? After all, physiological activation adequate for lucidity probably occurs every night during most REM periods; why then do we not become lucid more frequently? It appears plausible that we usually lack an appropriate pre-sleep, and thus, REM cognitive set (i.e., the intention to become conscious of our dreaming). Although the importance of physiological factors in the genesis of dream lucidity is clear, it seems equally clear that psychological factors are no less important.

It is also worth noting that the ability of lucid dreamers to deliberately perform dream actions in accordance with pre-sleep agreement makes possible an experimental paradigm allowing the methodical and precise determina-

Conscious Mind, Sleeping Brain

Perspectives on Lucid Dreaming

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The Psychophysiology of Lucid Dreaming

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LUCID DREAMING PHYSIOLOGICALLY VERIFIED

Although we are usually unaware of the fact that we are dreaming while we are dreaming, at times a remarkable exception occurs, and our consciousness becomes lucid enough for us to realize that we *are* dreaming. Lucid dreamers report being able to freely remember the circumstances of waking life, to think clearly, and to act deliberately upon reflection, all the while experiencing a dream world that seems vividly real (Green, 1968; LaBerge, 1985a). This is all in contrast to the usual characterization of dreams as typically lacking any reflective awareness or true volition (Rechtschaffen, 1978).

Indeed, the concept of *conscious sleep* can seem so self-contradictory and paradoxical to certain ways of thinking that some theoreticians have considered lucid dreams impossible and even absurd. Probably the most extreme example of this point of view is provided by Malcolm (1959), who argued that if being asleep means experiencing nothing whatsoever, "dreams" are not experiences during sleep at all but only the reports we tell after awakening. This concept of sleep led Malcolm to conclude that the idea that someone might reason while asleep is "meaningless." From here, the philosopher reasoned that

> If "I am dreaming" could express a judgment it would imply the judgment 'I am asleep,' and therefore the absurdity of the latter proves the absurdity of the former." Thus "the supposed judgement that one is dreaming" is "unintelligible" and "an inherently absurd form of words (Malcolm, 1959, pp. 48–50)

The point of this example is to show the skeptical light in which accounts of lucid dreaming were viewed before physiological proof of the reality of the

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phenomenon made philosophical arguments moot. As for the occasional reports in which dreamers claimed to have been fully conscious that they were dreaming *while* they were dreaming, the orthodox view in sleep and dream research assumed (until very recently) that anecdotal accounts of lucid dreams must be somehow spurious.

Nevertheless, people still reported dreaming the impossible dream, so the question was raised: "Under what presumably abnormal physiological conditions do reports of 'lucid' dreams occur?" In the absence of empirical ence bearing on the question, speculation largely favored two answers: either wakefulness or NREM sleep. Most sleep researchers were apparently inclined to accept Hartmann's "impression" that lucid dreams were "not typical parts of dreaming thought, but rather brief arousals" (Hartmann, 1975, p. 74; cf. Berger, 1977). Schwartz and Lefebvre (1973) noted that frequent transitory arousals were common during REM sleep and proposed these "microawakenings" as the physiological basis for lucid dream reports. Although no one had put forward any evidence for this mechanism, it seems to have been the received opinion (cf. Foulkes, 1974) up until the last few years. A similar view was put forward by Antrobus, Antrobus, and Fisher (1965) who predicted that recognition by the dreamer of the fact that he or she is dreaming would either immediately terminate the dream or continue in NREM sleep. Likewise, Hall (1977) speculated that lucid dreams may represent "a transition from Stage-1 REM to Stage-4 mentation" (p. 312). Green (1968) seems to have been alone in reasoning that, because lucid dreams usually arise from nonlucid dreams, "we may tentatively expect to find lucid dreams occurring, as do other dreams, during the 'paradoxical' phase of sleep" (p. 128).

Empirical evidence began to appear in the late 1970s supporting Green's speculation that lucid dreams occur during REM sleep. Based on standard sleep recordings of two subjects who reported a total of three lucid dreams upon awakening from REM periods, Ogilvie, Hunt, Sawicki, and McGowan (1978) cautiously concluded that "it *may* be that lucid dreams begin in REM" (p. 165). However, no proof was given that the reported lucid dreams themselves had in fact occurred during the REM sleep immediately preceding the awakenings and reports. Indeed, the subjects themselves were uncertain about when their lucid dreams had taken place. What was needed to unambiguously establish the physiological status of lucid dreams was some sort of on-the-scene report from the dream, an idea first suggested by Tart (1965).

LaBerge and his colleagues at Stanford University provided this verification by arranging for subjects to signal the onset of a lucid dream immediately upon realizing that they were dreaming by performing specific patterns of dream actions that would be observable on a polygraph (i.e., eye movements and fist clenches). Using this approach, LaBerge, Nagel, Dement, and Zarcone (1981) reported that the occurrence of lucid dreaming during unequivocal REM sleep had been demonstrated for five subjects. After being instructed in the method of lucid dream induction (MILD) described by LaBerge (1980b), the subjects were

recorded from 2 to 20 nights each. In the course of the 34 nights of the study, 35 lucid dreams were reported subsequent to spontaneous awaking from various stages of sleep as follows: REM sleep 32 times, NREM Stage-1, twice, and during the transition from NREM Stage-2 to REM, once. The subjects reported signaling during 30 of these lucid dreams. After each recording, the reports mentioning signals were submitted along with the respective polysomnograms to a judge uninformed of the times of the reports. In 24 cases (90%), the judge was able to select the appropriate 30-second epoch on the basis of correspondence between reported and observed signals. All signals associated with lucid dream reports occurred during epochs of unambiguous REM sleep scored according to the conventional criteria (Rechtschaffen & Kales, 1968).

A replication of this study with two additional subjects and 20 more lucid dreams produced identical results (LaBerge, Nagel, Taylor, Dement, & Zarcone, 1981). LaBerge *et al.* argued that their investigations demonstrated that lucid dreaming usually (though perhaps not exclusively) occurs during REM sleep. This conclusion is supported by research carried out in several other laboratories (Dane, 1984; Fenwick *et al.*, 1984; Hearne, 1978; Ogilvie, Hunt, Kushniruk, & Newman, 1983).

Ogilvie *et al.* (1983) reported the physiological state preceding 14 spontaneous lucidity signals as unqualified REM in 12 (86%) of the cases; of the remaining 2 cases, 1 was "ambiguous" REM and the other appeared to be wakefulness. Keith Hearne and Alan Worsley collaborated on a pioneering study of lucid dreaming in which the latter spent 50 nonconsecutive nights in the sleep lab while the former monitored the polygraph. Worsley reported signaling in eight lucid dreams, all of which were described by Hearne (1978) as having occurred during unambiguous REM sleep.

Brylowski, LaBerge, Levitan, Booth, and Nelson (1986) monitored a single skilled lucid dreamer for four nights while measuring the subject's H-reflex. The reflex was evoked every 5 seconds and later measured and analyzed for differences in suppression between lucid and nonlucid REM. They found that the H-reflex was significantly suppressed during lucid REM as compared to nonlucid REM ($p < .001$). Because H-reflex suppression is often considered a unique hallmark of REM sleep, this finding should finally lay to rest the notion that lucid dreams do not occur during REM.

However, demonstrations that signaling of lucid dreams occurs during REM sleep may raise another kind of question for some readers: What exactly do we mean by the assertion that lucid dreamers are "asleep?" Perhaps these "dreamers" are not really dreamers, as some argued in the last century; or perhaps this "sleep" is not really sleep, as some have argued in this century. How do we know that lucid dreamers are "really asleep" when they signal? If we consider perception of the external world as a criterion of being awake (to the external world), we can conclude that they are actually asleep (to the external world) because, although they know they are in the laboratory, this knowledge is a

tion of psychophysiological correspondence during REM dreaming. The viability of this approach has been demonstrated for a variety of dreamed behaviors including dreamed hand and eye movements, subjective estimation of temporal duration in the dream (LaBerge, 1985a), dreamed singing and counting (LaBerge and Dement, 1982a), voluntary alterations of respiration (LaBerge and Dement, 1982b), and dreamed sexual activity (LaBerge, Greenleaf, and Kedzierski, 1983).

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remaining 21 (28%) as WILDs. For 13 subjects, DILDs were more common than WILDs (binomial test, $p < .0001$). Compared to DILDs, WILDs were more frequently immediately preceded by physiological indications of awakening (Chi-squared = 38.3, 1 *df*, $p < .0001$), establishing the validity of classifying lucid dreams in this manner. See Figures 2 and 3 for illustrations of these two types of lucid dreams.

The distributions of DILD and WILD latencies from the onset of REM are significantly different (LaBerge, Levitan, & Dement, 1986). A Wald-Wolfowitz test demonstrated that WILDs do not occur as early or late in REM periods as DILDs do ($p < .0015$). This difference may be simply explained: As a matter of definition, a necessary condition for a WILD to occur is a transitory awakening followed by a return to REM sleep. If the awakening were to happen too near to the beginning of REM, the REM period might simply be aborted. Similarly, if the awakening were to occur too near to the "natural" end of the REM period, it would be more likely that REM would not resume but that wakefulness would persist or a NREM sleep stage would ensue.

To summarize, an elevated level of CNS activation seems to be a necessary condition for the occurrence of lucid dreams. Were this condition unnecessary,

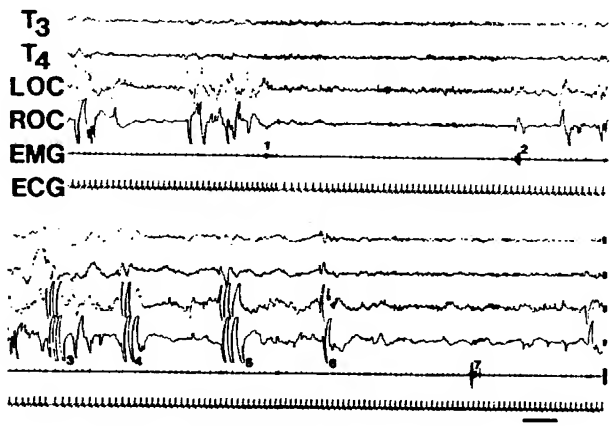

Figure 3. A typical lucid dream initiated from a transient awakening during REM (WILD). Six channels of physiological data (left and right temporal EEG [T_3 and T_4], left and right eye movements [LOC and ROC], chin muscle tone [EMG], and electrocardiogram [ECG]) from the last 3 min of a 14-min REM period are shown. The subject awoke at 1 and after 40 seconds returned to REM sleep at 2, and realized he was dreaming 15 s later and signaled at 3. Next he carried out the agreed-upon experimental task in his lucid dream, singing between signals 3 and 4, and counting between signals 4 and 5. This allowed comparison of left and right hemisphere activation during the two tasks (LaBerge & Dement, 1982b). Note the heart-rate acceleration-deceleration pattern at awakening (1) and at lucidity onset (3) and the skin potential potential artifacts in the EEG (particularly T_4) at lucidity onset (3). Calibrations are 50 μV and 5 seconds.

lucid dreams would be found randomly distributed within REM periods and perhaps every stage of sleep. Why then is CNS activation necessary for lucid dreaming? Evidently the high level of cognitive function involved in lucid dreaming requires a correspondingly high level of neuronal activation. In terms of Antrobus's (1986) adaptation of Anderson's (1983) ACT* model of cognition to dreaming, working memory capacity is proportional to cognitive activation, which in turn is proportional to cortical activation. Becoming lucid requires an adequate level of working memory to activate the presleep intention to recognize that one is dreaming. This level of activation is apparently not always available during sleep but normally only during phasic REM.

THE TEMPORAL DISTRIBUTION OF LUCID DREAMS

St. Thomas Aquinas mentioned "that sometimes while asleep a man may judge that what he sees is a dream, discerning as it were, between things and their images" and that this happens especially "towards the end of sleep, in sober men and those who are gifted with a strong imagination." (Aquinas, 1947, p. 430). Van Eeden (1913) stated that his lucid dreams invariably occurred between 5 and 8 o'clock in the morning. By way of explanation, he quoted Dante's characterization of these hours as the time "when swallows begin to warble and our mind is least clogged by the material body." Garfield (1975) exactly agreed with van Eeden's observation, though perhaps not with his poetic explanation. LaBerge (1979) plotted the times of 212 of his lucid dreams and found their pattern of occurrence closely fit the usual cyclic distribution of REM periods. He suggested that the fact that most REM sleep occurs toward the end of the night provided a plausible explanation for Van Eeden's and Garfield's observations. Later, LaBerge (1980a) tested this hypothesis by comparing the temporal distribution of his lucid dreams with that expected on the basis of normative data from Williams, Karacan, and Jursch (1974). A chi-square test indicated that the observed distribution of lucid dreams in the first three REM periods was not significantly different from what would be expected on the basis of mean REM period lengths at different times of the night.

Cohen (1979) argued that the left hemisphere shows a gradual increase in dominance across the night (but see Armitage, Hoffmann, Moffitt, & Shearer, 1985). Since left-hemisphere abstract symbolic functions are undoubtedly crucial for lucid dreaming, Cohen's GILD hypothesis led LaBerge (1985b) to predict that the probability of dream lucidity should increase with time of night.

This hypothesis was tested by LaBerge *et al.* (1986). For each of their 12 subjects, a median split for total REM time was determined; 11 of their subjects had more lucid dreams in the later half of their REM than in the earlier (binomial test; $p < .01$). For the combined sample, relative lucidity probability was calculated for REM periods 1 through 6 of the night by dividing the total number of

lucid dreams observed in a given REM period by the corresponding total time in stage REM for the same REM period. A regression analysis clearly demonstrated that relative lucidity probability was a linear function of ordinal REM period number ($r = .98, p < .0001$). No measure of activation (EM, RR, HR, SP) even approached significance when entered into the regression equation, indicating that the increase in lucid dream probability is not explained by a general increase in CNS activation across the night. These results strongly support the conclusion that lucid dreams are more likely to occur in later REM periods than in earlier ones—provided, of course, that sleep is continued long enough.

Another factor influencing the temporal distribution of lucid dreams is initiation type. LaBerge's (1987) personal record of lucid dreams indicates that, for him, W-type lucid dreams are over 10 times more frequent during afternoon naps than they are during the first REM period of the night ($p < .0002$).

EEG ALPHA ACTIVITY DURING REM LUCID DREAMS

The fact that lucid dreaming occurs during REM sleep partially defines the sort of EEG activity characteristic of lucid dreams. However, the standard criteria for determining REM sleep (Rechtschaffen & Kales, 1968) are quite general when referring to the EEG, being simply "relatively low voltage, mixed frequency," without specifying how much of which frequencies might be mixed. As noted previously, REM sleep is a labile and heterogeneous state. For example, during REM, the EEG sometimes shows predominant 2 to 3 Hz "sawtooth" waves, whereas at other times it may exhibit prominent 8 to 10 Hz alpha waves. Consequently, the question arises: Does the range of EEG activity characteristic of lucid dreams reliably differ in any way from that of nonlucid dreams?

In a series of studies, Ogilvie and colleagues have pursued the hypothesis that lucid dreams are associated with high levels of alpha activity. In the first of these investigations, they came to the initial "impression that alpha is the dominant EEG frequency during lucid dreams" on the rather shaky grounds of a comparison of "percent alpha in the EEG" of just two lucid dream REM periods with percentage alpha for six nonlucid dream REM periods for a *single* subject (Ogilvie, Hunt, Sawicki, & McGowan, 1978, p. 165).

Ogilvie, Hunt, Tyson, Lucescu, and Jeakins (1982) followed up their preliminary work with a larger study in which 10 subjects (all good dream recallers, with a wide range of lucid dreaming ability) were recorded 2 nights each in the sleep laboratory, during which they were awakened four times per night from REM sleep: half of the time during periods of relatively high alpha and half of the time during relatively low alpha. Dream reports were collected and rated on a lucidity scale by a judge blind to the awakening condition. Significantly higher lucidity ratings were obtained for high-alpha compared to low-alpha awakenings.

Several methodological problems of this study cast doubt on Ogilvie *et al.*'s

(1982) conclusion that lucid dreams are associated with high alpha activity. One is that the differences found between low and high alpha reports were based primarily on the degrees of *pre*lucidity in the reports. Even more important, we have no assurance of whether, in either condition, the episode of prelucidity or lucidity occurred in association with the final 20 to 30 second period of either high or low alpha activity that determined the awakening condition. Moreover, because none of the dreams classified as lucid were marked by any signals, we have no proof that they were in fact lucid dreams, nor in any case do we have any way of determining what the degree of alpha activity was *during* the frequently brief episodes of lucidity.

Because of Ogilvie *et al.*'s (1982) design, we cannot exclude the possibility that what their study may actually have demonstrated is that the tendencies of subjects to retrospectively judge themselves to have been briefly or partially lucid vary with the amount of alpha activity either just before or during the process of awakening. Support for this interpretation comes from an earlier study, which concluded that mentation reports collected from REM periods showing EEGs with a high proportion of alpha waves were associated with "some feeling of control over the content" and were frequently labeled by subjects as "thoughts" rather than "dreams" (Goodenough, Shapiro, Holden, & Steinschriber, 1959).

There is another possible design problem with the Ogilvie *et al.* (1982) study that seems serious enough to merit mention: The judges' lucidity ratings were based not upon the spontaneous dream reports but on the subjects' answers to rather leading questions subsequently posed by the interviewer, such as "Was there any point when you wondered whether or not you might be dreaming?" and "Was there any point at which you knew you were dreaming while the dream was going on?" The demand characteristics should be obvious. Additionally, there is a problem that retrospective judgments about earlier states of mind are likely to be confounded by our current mental state. Cognitive capacities we currently possess are likely to be mistakenly remembered as having been present in an earlier state. A conservative approach should perhaps put more weight on the original dream reports; in the present context, one would like to know how many subjects spontaneously mentioned in their reports that they had been prelucid or lucid.

In a more recent study, Ogilvie *et al.* (1983) remedied several of these methodological problems and arrived at a conclusion regarding alpha activity and lucidity unsupportive of their earlier work. They studied eight lucid dreamers for 1 to 4 nights in a sleep lab. The subjects were awakened from REM following spontaneous or cued eye movement signals. The cue buzzer sounded after 15 minutes of REM during periods of either high or low alpha activity. The subjects were to signal at the cue and again 30 seconds later if in a lucid dream. Reports were elicited 30 to 60 seconds after cued or spontaneous signals and rated for lucidity. Contrary to their earlier findings, the low-alpha condition yielded

slightly more lucid dreams than the high-alpha condition; however, this difference was not statistically significant. Addressing this same issue, LaBerge (1980b) performed a Fourier analysis on EEG activity (C3/A1) for a single lucid dream REM period. Comparison of the spectral profiles for the lucid and nonlucid portions of the REM period revealed alpha activity for the nonlucid portion to more closely resemble the waking EEG spectrum than did that in the lucid portion; however, the two REM samples did not significantly differ.

In summary, it would seem that at this point no reliable association of lucid dreaming with alpha activity (whether high or low) has been established. A more productive approach to the question of EEG in lucid versus nonlucid REM would probably involve quantifying whole-band EEG frequency spectra from several electrode placements and comparing signal-verified lucid dreams with nonlucid controls.

NREM LUCID DREAMS

The findings summarized here indicating that lucid dreams typically occur in REM sleep should not be misconstrued to suggest that lucid dreams never occur in NREM sleep. In fact, in LaBerge, Nagel, Dement and Zarcone's initial study (1981), lucid dreams were reported by two subjects after spontaneous awakening from NREM sleep (Stage-2 once; Stage-1, twice). The Stage-2 report indicated only a brief moment of lucidity before awakening; because the subject was unable to signal while lucid we cannot be certain that her experience took place during Stage-2 sleep and not while awakening. As for the NREM Stage-1 reports, although the subject reported signaling before awakening on these occasions, no signals could be verified on her polysomnogram.

LaBerge (1980a) polysomnographically recorded a single trained subject during sleep onset on 3 consecutive nights. The subject reported a rich history of hypnagogic imagery. On the experimental nights, she made an effort to retain consciousness while entering sleep-onset dream states. "Dreaming" was distinguished from other sleep-onset mentation by the two requirements that (1) the subject was subjectively asleep (i.e., unaware of the actual position of her body in bed) and (2) that she hallucinated her body within the dream scene.

On each of the experimental sessions (lasting about 2 hours), the subject repeatedly rested quietly, but vigilantly, and while drifting off to sleep counted to herself ("One, two, three, . . .") until she began to dream, at which point she awakened and tape-recorded a mentation report. In 25 of the 42 resultant dream reports (all of which were very short), the subject claimed to have been lucid. The following is a typical report: "I am in the grocery store, going down an aisle; only I am standing on a cart. It is whizzing real fast. As I go by the Coke and Pepsi bottles, I realize that I am dreaming. I think to look at my hands, but they won't move up to eye level" (p. 101). Note the absence of voluntary control over the body image, a very unusual condition for REM lucid dreams. Visual inspection of the polygraph record showed all of these "dreamlets" to have occurred during Stage-1 sleep, with slow eye movements.

This pilot study makes it clear that the observed frequency of NREM lucid dreaming will depend on experimental demand characteristics. The same point is made by Dane (1983), who found a high proportion of lucid dream reports deriving from NREM under conditions of heightened attention during sleep onset and explicit instructions that "dreams occur during NREM as well as during REM sleep" (p. 249). A comparative study of REM versus NREM (and "waking") lucid dreaming clearly needs to be done.

PSYCHOPHYSIOLOGICAL RELATIONSHIPS DURING REM SLEEP

One of the major obstacles impeding the development of human consciousness as a topic of rigorous scientific study has been that the only direct account available of the private events occurring in a person's mind is his or her own subjective report. Subjective reports, unfortunately, are not subject to objective verification—at least not directly. To make matters worse, of all the "bad witnesses"—as Heraclitus called the senses—"introspection" appears to be the least reliable. Introspection is not really even a sense: We do not simply "look and see" the contents of our minds; what we "see" there is largely dependent on what we *expect* to see based on our theories of ourselves. These theories tend to portray ourselves as more consistent and rational than we really are (Nisbett & Wilson, 1977). Given that the only witness is of uncertain reliability, what we need in order to study consciousness more objectively is a means of corroborating the testimony of the "I-witness," and this is precisely the role of the psychophysiological approach. A key element in this new strategy is the idea of making full use of the subject's cooperativeness and intelligence. A frequent practice in experimental psychology requires the deception of subjects about the true nature of the experiment. This has the advantage of minimizing the effect the subject's knowledge might have on the experiment. But this particular methodology is inappropriate when the object of the investigation is the subject's own consciousness. In this case, a more suitable approach is one in which the dichotomous subject/experimenter relationship is modified: Perhaps subjects should be regarded as—to borrow an anthropological term—participant–observers.

What about the problem of the uncertain reliability of introspective accounts of consciousness? There are two strategies likely to increase our confidence in the reliability of subjective reports: In the first place, it helps to study highly trained (and lucid) subjects who are skillful reporters. Second, we can make use of the fact that the convergent agreement of physiological measures and subjective reports provides a degree of validation to the latter (Stoyva and Kamiya, 1968).

The fact that lucid dreamers can remember to perform predetermined ac-

tions and signal to the laboratory as suggested by LaBerge (1980a), a new approach to dream research: Lucid dreamers, he proposed,

> could carry out diverse dream experiments marking the exact time of particular dream events, allowing the derivation of precise psychophysiological correlations and the methodical testing of hypotheses. (LaBerge, Nagel, Dement, & Zarcone, 1981, p. 727)

This strategy has been put into practice by the Stanford group in a number of studies summarized by LaBerge (1985a).

LaBerge first of all pointed out that the data reported in LaBerge, Nagel, Dement, and Zarcone (1981) and LaBerge, Nagel, Taylor, Dement, and Zarcone (1981) indicate that there is a very direct and reliable relationship between gaze shifts reported in lucid dreams and the direction of polygraphically recorded eye movements. It should be noted that the results obtained for lucid dreams (see also Dane, 1984; Fenwick *et al.*, 1984; Hearne, 1978; Ogilvie, *et al.*, 1982) are much stronger than the generally weak correlations demonstrated by earlier investigations testing the notion that the dreamer's eyes move with his or her hallucinated dream gaze, which had to rely on the chance occurrence of a highly recognizable eye movement pattern that was readily matchable to the subject's reported dream activity (e.g., Roffwarg, Dement, Muzio, & Fisher, 1962). This would seem to illustrate the methodological advantage of using lucid dreamers.

LaBerge (1980a, 1985a) reports having straightforwardly approached the problem of dream time by asking subjects to estimate various intervals of time during their lucid dreams. Signals marking the beginning and end of the subjective intervals allowed comparison with objective time. In all cases, LaBerge reported, time estimates during the lucid dreams were very close to the actual time between signals.

In another study, LaBerge and Dement (1982a) demonstrated the possibility of voluntary control of respiration during lucid dreaming. They recorded three lucid dreamers who were asked to either breathe rapidly or to hold their breaths (in their lucid dreams), marking the invertal of altered respiration with eye movement signals. The subjects reported successfully carrying out the agreed-upon tasks a total of nine times, and in every case, a judge was able to correctly predict on the basis of the polygraph recordings which of the two patterns had been executed ($p < .002$).

Evidence of voluntary control of other muscle groups during REM was found by LaBerge, Nagel, Dement, and Zarcone (1981) while testing a variety of lucidity signals. They observed that a sequence of left and right dream-fist clenches resulted in a corresponding sequence of left and right forearm twitches as measured by EMG. However, the amplitude of the twitches bore an unreliable relationship to the subjective intensity of the dreamed action. Because all skeletal muscle groups except those that govern eye movements and breathing suffer a profound loss of tone during REM sleep, it is to be expected that most muscular responses to dreamed movements will be feeble. Nonetheless, these responses

faithfully reflect the dreamer's body responds to dreamed actions with movements that are but shadows of the originals.

Further support of this notion comes from a study (Fenwick *et al.*, 1984) of a single highly proficient lucid dreamer (Alan Worsley, who had also been Hearne's [1978] subject) who carried out a variety of dreamed muscular movements while being polygraphically recorded. In one experiment, Worsley executed movements during lucid dreams involving finger, forearm, and shoulder muscle groups (flexors) while EMG was recorded from each area. The results were consistent: The axial muscles showed no measurable EMG activity, whereas the forearm EMG "consistently showed lower amplitude and shorter bursts" compared to the finger EMG. A similar experiment with the lower limbs yielded similar results. In addition to the finding that REM atonia shows a central-peripheral gradient with motor inhibition least for the most distal muscles, Fenwick *et al.* reported that similar experiments comparing EMG response to dreamed arm and leg flexions and extensions suggested that flexors were less inhibited than extensors. In addition to EMG, an accelerometer was utilized in several experiments demonstrating that Worsley was able to produce minor movements of his fingers, toes, and feet during REM, though not of his legs. Fenwick *et al.* also presented the results of a single experiment suggesting that dream speech may be initiated in the expiratory phase of respiration just as it usually does during waking. In still another experiment they demonstrated the voluntary production of smooth pursuit eye movements during a lucid dream. LaBerge (1986) has carried out related experiments in which two subjects tracked the tip of their fingers moving slowly left to right during four conditions: (1) awake, eyes open; (2) awake, eyes closed mental imagery; (3) lucid dreaming; and (4) imagination ("dream eyes closed") during lucid dreaming. The subjects showed saccadic eye movements in the two imagination conditions (2 and 4), and smooth-tracking eye movements during dreamed or actual tracking (conditions 1 and 3).

Fenwick *et al.* also showed that Worsley was able to perceive and respond to environmental stimuli (electrical shocks) without awakening from his lucid dream. This result raises a theoretical issue: If we take perception of the external world to be the essential criterion for wakefulness (LaBerge, Nagel, Dement, & Zarcone, 1981), then it would seem that Worsley must have been at least partially awake. On the other hand, when environmental stimuli are incorporated into dreams without producing any subjective or physiological indications of arousal, it appears reasonable to speak of the perception as having occurred during sleep. Furthermore, it may be possible, as LaBerge (1980c) has suggested, for one sense to remain functional and "awake" while others fall "asleep." As long as we continue to consider wakefulness and sleep as a simple dichotomy, we will lie in a Procrustian bed that is bound at times to be most uncomfortable. There must be degrees of being awake just as there are degrees of

being asleep (i.e., the conventional sleep stages). Before finding our way out of this muddle, we will probably need to characterize a wider variety of states of consciousness than those few currently distinguished (e.g., dreaming, sleeping, waking, and so on).

Because many researchers have reported cognitive task dependency of lateralization of EEG alpha activity in the waking state, LaBerge undertook a pilot study to determine whether similar relationships would hold in the lucid dream state. The two tasks selected for comparison were dreamed singing and dreamed counting, activities expected to result in relatively greater engagement of the subjects' left and right cerebral hemispheres, respectively.

Integrated alpha band EEG activity was derived from electrodes placed over right and left temporal lobes while four subjects sang and counted in their lucid dreams (marking the beginning and end of each task by eye movement signals). The results supported the hypothesized lateralization of alpha activity: The right hemisphere was more active than the left during singing; during counting the reverse was true. These shifts were similar to those observed during actual singing and counting (LaBerge & Dement, 1982b).

Sexual activity is a rather commonly reported theme of lucid dreams (Garfield, 1979; LaBerge, 1985a). However, at this point, only a single physiological investigation of lucid dream sex has been published. LaBerge, Greenleaf, and Kedzierski (1983) undertook a pilot study to determine the extent to which subjectively experienced sexual activity during REM lucid dreaming would be reflected in physiological responses. Their subject was a highly proficient lucid dreamer who spent the night sleeping in the laboratory. Sixteen channels of physiological data, including EEG, EOG, EMG, respiration, skin conductance level (SCL), heart rate, vaginal EMG (VEMG), and vaginal pulse amplitude (VPA), were recorded. The experimental protocol called for the subject to make specific eye movement signals at the following points: when she realized she was dreaming (i.e., the onset of the lucid dream); when she began sexual activity (in the dream); and when she experienced orgasm. The subject reported a lucid dream in which she carried out the experimental task exactly as agreed upon. Data analysis revealed a significant correspondence between her subjective report and all but one of the autonomic measures; during the 15-second orgasm epoch, mean levels for VEMG activity, VPA, SCL, and respiration rate reached their highest values and were significantly elevated compared to means for other REM epochs. Contrary to expectation, heart rate increased only slightly and nonsignificantly.

LaBerge (1985a) reports replicating this experiment using two male subjects. In both cases, respiration showed striking increases in rate. Again, there were no significant elevations of heart rate. Interestingly, although both subjects reported vividly realistic orgasms in their lucid dreams, neither actually ejaculated, in contrast to the "wet dreams" commonly experienced by adolescent

males. The mechanism of nocturnal emissions is probably local reflex irritability because wet dreams do not necessarily involve dream content of a sexual nature, again in contrast to lucid dream orgasms, which are obviously sexual; it appears we have two extreme cases: "bottom-up" versus "top-down" orgasms.

All of these results support the conclusion that the events we experience while asleep and dreaming produce effects on our brains (and to a lesser extent, bodies) remarkably similar to those that would be produced if we were actually to experience the corresponding events while awake. The reason for this is probably that the multimodal imagery of the dream is produced by the same brain systems that produce the equivalent perceptions (cf. Finke, 1980). Perhaps this is why dreams seem so real: To our brains, dreaming of doing something is equivalent to actually doing it.

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